TETRA TECH

Walhampton Drive Area Stormwater Improvements Design Alternatives

for

Lexington-Fayette Urban County Government
Division of Water Quality

September 14, 2012
Revised January 14, 2013

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Division of Water Quality
125 Lisle Industrial Road
Lexington, Kentucky 40504

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Tetra Tech, Inc.
800 Corporate Drive, Suite 200
Lexington, Kentucky 40503

http://www.tetratech.com

Phone: 859.223.8000
Toll Free: 800.726.8001
Fax: 859.224.1025

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BACKGROUND

The Walhampton Drive area of the Devondale Neighborhood has a history of stormwater issues and flooding of existing homes and streets. The area of concern includes sections of Walhampton Drive, Kenlock Drive, Habersham Drive, and East Tiverton Way. Tetra Tech, Inc. (Tt) was retained by Lexington-Fayette Urban County Government (LFUCG) to review the findings of previous studies, verify previously developed hydrologic/hydraulic modeling, and implement a design solution to mitigate the impact of home and street flooding through stormwater infrastructure improvements.

This document will specifically outline ten potential design alternatives for the Walhampton Area. The design alternatives have been developed using the verified and certified model from past studies in this area.

APPROACH

Tt received a hydrologic/hydraulic model previously completed by Sherman Carter Barnhart, PSC. Tt made slight modifications to the model and has verified the output and calibrated the model to past flooding events (particularly witness reports from September 2006). Using the model, design alternatives were evaluated, noting the impact to flooding conditions, hydraulic grade elevations, and peak discharges for the 25 year – 24 hour and 100 year – 24 hour storms. A map of the model showing the watershed sub-basins and the pipe network can be found on Sheet W-01 in Appendix A. A map showing the existing conditions pipe network for the models can be found on Sheet PN-01 in Appendix E.

Each of the design alternatives outlined in this report has a narrative describing the proposed design and modeling results, an Engineer's Opinion of Probable Project Cost, and a Figure showing the design. A summary of the modeling results comparing all design options with estimated costs can be found on page 21.

A review of the CCTV inspection performed by LFUCG indicated that some of the flooding issues around the Walhampton area appear to be directly related to the integrity of the storm sewer in this area. It was noted that one segment of 54 inch pipe from the manhole in the rear yard of 378 Tangley Way to the manhole in the street in front of 240 East Tiverton Way was slightly reverse sloped to the direction of flow. Other blockages were encountered that hindered further inspection with the robotic camera. These blockages were found in the following pipe segments:

- WH10_566_WH10_564
- WH10_577MH_WH10_578MH
- WH10_548_WH10_547HW
- WH10_544CI_WH10_543CI
- WH10_544CI_WH10_552MH.

The full CCTV scoring summary and ratings exhibit can be found in Appendix A.

OPTION 1

The first option focuses on the creation of a detention basin that will reduce the peak flows into the system and free-up capacity in the existing storm sewer system. The location of the basin will be at the low point on the Fritz farm, just upstream of the existing 30 inch headwall. 3837 and 3833 Walhampton Drive will be demolished to allow for construction of the detention basin dam. Along with the basin, portions of the existing 30 inch reinforced concrete pipe (RCP) will be replaced with 42 inch RCP. The new 42 inch RCP will run from the backyard of 245 Kenlock Drive to the existing 48 inch RCP located in the rear yard of 221 Kenlock Drive. 260 linear feet of existing 48 inch RCP and 156 linear feet of the existing 54 inch RCP will be replaced with a 43 inch x 68 inch horizontal elliptical pipe and placed on a positive slope. The elliptical pipe is proposed to help limit vertical conflicts with other existing utilities in the area. In the cost estimate, due to the high cost of elliptical pipe, an alternate bid item for equivalent sized circular pipe has been provided in the event that the vertical limits allow it to be used. Figure 1 in Appendix B shows the proposed layout and elements for Design Option 1.

With the proposed improvements in place the flooding conditions would be improved at each problem area. The maximum water surface elevations for the 25 year – 24 hour and 100 year – 24 hour storm at historical overflow locations, along with flows at the discharge point of the system and net changes in the downstream discharge can be found in Table 1.1. The design storm used for this is the 25 year – 24 hour storm, as required by LFUCG. The top of dam elevation for the new detention basin is 970.00 and the maximum water surface elevation in the design storm is 968.04, allowing 1.9 feet of freeboard for this storm event. At the outlet structure for this design option the peak discharge is slightly increased from 134.51 cfs to 148.11 cfs in the 25 year – 24 hour storm.

The full model report for the 25 year – 24 hour storm of Option 1 can be found in Appendix C. Sheet P-01 in Appendix D shows a profile of the proposed improvements and the hydraulic grade line. The model pipe network map can be found on Sheet PN-02 and a layout sheet showing the preliminary design on Sheet LS-01, both sheets are in Appendix E.

Table 1.1 – Design Option 1 Modeling Results

Storm Event	30" headwall at Fritz property top of dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Rim 960.91 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.04	964.41 (below grade)	959.31 (below grade)	148.11	62.27	210.38	22.85
Ex. Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	970	965.6	960.91	174.22	95.18	269.4	18.89
Ex. Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 1 is $1,797,032.15. See page 4 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #1

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition for Basin, Diversion Channel, and Easements	LS	1	$595,000.00	$595,000.00
2	Mobilization	LS	1	$47,056.50	$47,056.50
3	Demolition	LS	1	$185,000.00	$185,000.00
4	Unclassified Excavation	CY	24,000	$8.00	$192,000.00
5	Erosion and Sediment Control	LS	1	$42,675.00	$42,675.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	900	$32.25	$29,025.00
8	Fence Replacement	LF	550	$10.00	$5,500.00
9	Sodding	SY	29,000	$4.50	$130,500.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	5	$3,500.00	$17,500.00
11	Stormsewer Manholes - Type B, 7'	Each	4	$5,000.00	$20,000.00
12	42" RCP	LF	1,000	$130.00	$130,000.00
13	43" x 68" Elliptical RCP	LF	420	$450.00	$189,000.00
14	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
15	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
16	24" RCP	LF	300	$65.00	$19,500.00
17	Sidewalk Replacement	SY	225	$40.00	$9,000.00
18	Basin Outlet Structure	LS	1	$7,000.00	$7,000.00
19	Stripping Stockpile Soil	CY	2,000	$5.00	$10,000.00
	10% Contingency				$109,275.65
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 19)					**$1,797,032.15**

Alt 1	54" RCP (to replace 43" x 68" Elliptical RCP)	LF	420	$225.00	$94,500.00
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 12, 14 thru 19, and Alt 1)					**$1,693,082.15**

OPTION 2

The second option decreases flooding without the addition of a detention basin. The focus in Option 2 is to increase water capacity and conveyance through increasing the pipe sizes from the Fritz property all the way to the outlet. The existing 30 inch RCP will be increased to a 76 inch x 48 inch elliptical pipe. After 465 linear feet, the elliptical pipe changes in size to an 83 inch x 53 inch elliptical pipe, and extends for another 500 feet. From this point, the same 83 inch x 53 inch elliptical pipe will be routed in a new direction down Kenlock Drive, turning at Habersham Drive. The existing pipes behind Kenlock Drive will remain in place and would be available as an overflow to the new system. After the new elliptical pipe turns onto Habersham, it will extend to the East Tiverton Way intersection, turn east and replaces the existing 57 inch x 38 inch (approximate) elliptical pipe to the outlet. Figure 2 in Appendix B shows the proposed layout and elements for Design Option 2.

In this option the 25 year – 24 hour design storm shows flooding conditions at the Kenlock Drive backyard low area. There is also a significant increase in total downstream discharge from Option 1, increasing from 210.38 cfs to 286.71 cfs. There are also concerns with vertical conflicts at sewer crossings by taking the path of the existing 57 inch x 38 inch elliptical pipe. A summary of the modeling results from Option 2 can be found in Table 2.1.

Table 2.1 – Design Option 2 Modeling Results

Storm Event	30" headwall at Fritz property overflow at 968.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Rim 960.91 (WSE)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	966.65	963.87 (below grade)	961.55	118.22	168.49	286.71	99.18
Existing Conditions	968.99	968.19	964.61	53.02	134.51	187.53	
100 year 24 hour	968.82 (64.38 cfs overflow)	966.05 (below grade)	961.55	133.34	179.02	312.36	61.85
Existing Conditions	969.5	968.79	965.07	75.44	175.07	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 2 is $1,766,232.09. See page 6 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #2

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition for Easements	LS	1	$8,000.00	$8,000.00
2	Mobilization	LS	1	$68,830.31	$68,830.31
3	Demolition	LS	1	$35,000.00	$35,000.00
4	Unclassified Excavation	CY	700	$8.00	$5,600.00
5	Erosion and Sediment Control	LS	1	$18,175.00	$18,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	1,750	$32.25	$56,437.50
8	Fence Replacement	LF	460	$10.00	$4,600.00
9	Sodding	SY	9,700	$4.50	$43,650.00
10	Stormsewer Manholes - Type B, 7'	Each	10	$5,000.00	$50,000.00
11	76"x48" Concrete Channel	LF	500	$450.00	$225,000.00
12	83"x53" Concrete Channel	LF	2,000	$500.00	$1,000,000.00
13	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
14	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
15	24" RCP	LF	300	$65.00	$19,500.00
16	Sidewalk Replacement	SY	315	$40.00	$12,600.00
	10% Contingency				$159,839.28
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 16)					**$1,766,232.09**

Alt 1	60" RCP (to replace 76" x 48" Elliptical RCP)	LF	500	$280.00	$140,000.00
Alt 2	72" RCP (to replace 83" x 53" Elliptical RCP)	LF	2000	$325.00	$650,000.00
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 10, 13 thru 16, Alt 1, and Alt 2)					**$1,464,355.30**

OPTION 3

In Option 3, the homes at 3837 and 3833 Walhampton Drive will be demolished and a detention basin would be constructed on those properties with a top of basin elevation of 970.00. Due to the smaller size of this basin compared to the proposed basin in Option 1, the 30 inch pipe will be replaced with a 42 inch pipe from the new basin to the low area in the rear yard at 245 Kenlock Drive. From that point the storm pipes will be replaced with a 76 inch x 48 inch horizontal elliptical pipe, and follow the same alignment as in Option 2. Figure 3 in Appendix B shows the proposed layout and elements for Design Option 3.

The modeling results for Option 3 shows the relief of upstream flooding and moderate increases in peak discharges in the 25 year – 24 hour storm. Similar to Option 2, that uses the path of the existing 57 inch x 38 inch elliptical pipe, there are concerns of vertical conflicts at sewer crossings. A full summary of the modeling results for Option 3 can be found in Table 3.1.

Table 3.1 – Design Option 3 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Rim 960.91 (WSE)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.38	962.97 (below grade)	960.62	80.63	168.21	248.84	61.31
Existing Conditions	968.99	968.19	964.61	53.02	134.51	187.53	
100 year 24 hour	969.0	965.26 (below grade)	961.55	85.97	179.02	264.99	14.48
Existing Conditions	969.5	968.79	965.07	75.44	175.07	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 3 is $1,688,374.69. See page 8 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #3

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition and Easements	LS	1	$212,000.00	$212,000.00
2	Mobilization	LS	1	$57,796.31	$57,796.31
3	Demolition	LS	1	$35,000.00	$35,000.00
4	Unclassified Excavation	CY	5,200	$8.00	$41,600.00
5	Erosion and Sediment Control	LS	1	$18,175.00	$18,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	1,750	$32.25	$56,437.50
8	Fence Replacement	LF	460	$10.00	$4,600.00
9	Sodding	SY	9,700	$4.50	$43,650.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	1	$3,500.00	$3,500.00
11	Stormsewer Manholes - Type B, 7'	Each	10	$5,000.00	$50,000.00
12	76"x48" Concrete Channel	LF	2,000	$450.00	$900,000.00
13	42" RCP	LF	310	$130.00	$40,300.00
14	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
15	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
16	24" RCP	LF	300	$65.00	$19,500.00
17	Sidewalk Replacement	SY	315	$40.00	$12,600.00
	10% Contingency				$134,215.88
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 17)					**$1,688,374.69**

Alt 1	60" RCP (to replace 76" x 48" Elliptical RCP)	LF	2000	$280.00	$560,000.00
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 11, 13 thru 17, and Alt 1)					**$1,411,364.69**

OPTION 4

The fourth option is similar to Option 3. Four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe will be increased in size to a 42 inch pipe from the basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive. Downstream of the Kenlock basin, the pipe size will increase to a 60 inch pipe out to the outlet structure north of East Tiverton Way. The path of the 60 inch pipe will be along the existing storm sewer path, similar to Option 1. Figure 4 in Appendix B shows the proposed layout and elements for Design Option 4.

The modeling results for Option 4 are similar to those found in Option 3. Option 4 shows a slight improvement in upstream flooding elevations and a reduction in peak flows from Option 3. A full summary of the modeling results for Option 4 can be found in Table 4.1.

Table 4.1 – Design Option 4 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	967.09	962.69	958.64	192.71	53.03	245.74	58.21
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.65	963.18	959.86	215.95	75.53	291.48	40.97
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 4 is $1,861,315.27. See page 10 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #4

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition and Easements	LS	1	$415,000.00	$415,000.00
2	Mobilization	LS	1	$56,619.56	$56,619.56
3	Demolition	LS	1	$355,000.00	$355,000.00
4	Unclassified Excavation	CY	13,000	$8.00	$104,000.00
5	Erosion and Sediment Control	LS	1	$25,175.00	$25,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	350	$32.25	$11,287.50
8	Fence Replacement	LF	550	$10.00	$5,500.00
9	Sodding	SY	14,500	$4.50	$65,250.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	3	$3,500.00	$10,500.00
11	Stormsewer Manholes - Type B, 7'	Each	8	$5,000.00	$40,000.00
12	60" RCP	LF	1,700	$280.00	$476,000.00
13	42" RCP	LF	600	$130.00	$78,000.00
14	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
15	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
16	24" RCP	LF	300	$65.00	$19,500.00
17	Sidewalk Replacement	SY	225	$40.00	$9,000.00
	10% Contingency				$131,483.21
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 17)					**$1,861,315.27**

OPTION 5

In the fifth option four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe will be increased in size to a 42 inch pipe from the basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive. Downstream of the Kenlock basin, the existing 30 inch pipe will be increased to a 42 inch pipe and the remainder of the existing pipes will remain in service to the outlet headwall. Figure 5 in Appendix B shows the proposed layout and elements for Design Option 5.

The modeling results for Option 5 are similar to those found in Option 4 thru the proposed basin at 245 Kenlock Drive. However Option 5 shows system over flows during the 25 year 24 hour storm event at the storm manhole in front of 233 Kenlock, in front of 221 Kenlock, and the storm inlet at in the back of 221 Kenlock. Since over flows occurred with this scenario during the 25 year 24 hour storm event further evaluation was not considered and an opinion of cost was not developed for Option 5. A full summary of the modeling results for Option 5 can be found in Table 5.1.

Table 5.1 – Design Option 5 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	967.23	964.04	960.69	175.38	53.03	228.41	40.88
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.58	966.74	961.38	212.40	75.51	287.91	37.40
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

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OPTION 6

The sixth option is similar to Option 4. Four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe from the proposed basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive will remain in service. Downstream of the Kenlock basin, the pipe size will increase to a 60 inch pipe out to the outlet structure north of East Tiverton Way. The path of the 60 inch pipe will be along the existing storm sewer path, similar to Option 1. Figure 6 in the Appendix shows the proposed layout and elements for Design Option 6.

The modeling results for Option 6 are similar to those found in Option 4. Option 6 shows a reduction in peak flows from Option 4. A full summary of the modeling results for Option 6 can be found in Table 6.1.

Table 6.1 – Design Option 6 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.62	964.29	957.92	154.36	53.03	207.39	19.86
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.85	968.15	962.00	198.20	75.71	273.91	23.40
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 6 is $1,804,759.87. See page 13 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #6

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition and Easements	LS	1	$415,000.00	$415,000.00
2	Mobilization	LS	1	$54,405.56	$54,405.56
3	Demolition	LS	1	$355,000.00	$355,000.00
4	Unclassified Excavation	CY	13,000	$8.00	$104,000.00
5	Erosion and Sediment Control	LS	1	$25,175.00	$25,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	350	$32.25	$11,287.50
8	Fence Replacement	LF	550	$10.00	$5,500.00
9	Sodding	SY	14,500	$4.50	$65,250.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	3	$3,500.00	$10,500.00
11	Stormsewer Manholes - Type B, 7'	Each	8	$5,000.00	$40,000.00
12	60" RCP	LF	1,700	$280.00	$476,000.00
13	42" RCP	LF	260	$130.00	$33,800.00
14	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
15	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
16	24" RCP	LF	300	$65.00	$19,500.00
17	Sidewalk Replacement	SY	100	$40.00	$4,000.00
	10% Contingency				$126,341.81
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 17)					**$1,804,759.87**

OPTION 7

The seventh option is similar to Option 6 with the exception that the existing 48 inch pipe on East Tiverton Way will be combined with the proposed 60 inch pipe. Four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe from the proposed basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive will remain in service. Downstream of the Kenlock basin, the pipe size will increase to a 60 inch pipe out to the outlet structure north of East Tiverton Way. The path of the 60 inch pipe will be along the existing storm sewer path, similar to Option 1. Figure 7 in Appendix B shows the proposed layout and elements for Design Option 7.

The modeling results for Option 7 are similar to those found in Option 6. Option 7 shows a slight reduction in peak flows from Option 6. However, the modeled water surface elevation for the 25 year – 24 hour event is slightly higher than the surface elevation of the storm inlets along East Tiverton Way downstream of where the 48 inch pipe and the proposed 60 inch pipe are combined. Since an over flow would occur in the street the 25 year – 24 hour or any larger storm event, further evaluation was not considered and an opinion of cost was not developed for Option 7. A full summary of the modeling results for Option 7 can be found in Table 7.1.

Table 7.1 – Design Option 7 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.62	964.29	958.05	199.34	0.00	199.34	11.81
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.85	968.15	962.00	225.03	0.00	225.03	-25.48
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

OPTION 8

In option eight, four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe from the proposed basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive will remain in service. Downstream of the Kenlock basin, the pipe size will increase to a 36 inch pipe out to the existing storm manhole located in the rear yard of 221 Kenlock Drive that combines the Walhampton and Harvard drainage systems. From that manhole the pipe will be increased to 54 inches. The reverse sloped 54 inch pipe will be replaced and will tie back in to the existing manhole in East Tiverton Way. Figure 8 in Appendix B shows the proposed layout and elements for Design Option 8.

In this option the 25 year – 24 hour design storm is contained below grade throughout the system. There is a slight increase in the downstream discharge compared to existing conditions, showing a net increase of 11.28 cfs. The 100 year – 24 hour storm would cause flooding conditions in this option. A full summary of the modeling results for Option 8 can be found in Table 8.1.

Table 8.1 – Design Option 8 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.65	964.60	959.77	145.78	53.03	198.81	11.28
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.86	968.16	961.72	177.58	75.51	253.09	2.58
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 8 is $1,467,252.30. See page 16 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #8

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition and Easements	LS	1	$415,000.00	$415,000.00
2	Mobilization	LS	1	$41,193.00	$41,193.00
3	Demolition	LS	1	$355,000.00	$355,000.00
4	Unclassified Excavation	CY	13,000	$8.00	$104,000.00
5	Erosion and Sediment Control	LS	1	$25,175.00	$25,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	300	$32.25	$9,675.00
8	Fence Replacement	LF	550	$10.00	$5,500.00
9	Sodding	SY	14,500	$4.50	$65,250.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	3	$3,500.00	$10,500.00
11	Stormsewer Manholes - Type B, 7'	Each	3	$5,000.00	$15,000.00
12	30" RCP	LF	160	$80.00	$12,800.00
13	36" RCP	LF	450	$105.00	$47,250.00
14	54" RCP	LF	850	$215.00	$182,750.00
15	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
16	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
17	24" RCP	LF	300	$65.00	$19,500.00
18	Sidewalk Replacement	SY	100	$40.00	$4,000.00
	10% Contingency				$95,659.30
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 18)					**$1,467,252.30**

OPTION 9

The ninth option is similar to the eighth. Four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe from the proposed basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive will remain in service. Downstream of the Kenlock basin, the pipe size will increase to a 36 inch pipe out to the existing storm manhole located in the rear yard of 221 Kenlock Drive that combines the Walhampton and Harvard drainage systems. From that manhole the pipe will be increased to 54 inches. The reverse sloped 54 inch pipe will be replaced and will tie back in to the existing manhole in East Tiverton Way. A new junction structure will be installed in East Tiverton Way and will connect both drainage systems, the 54 inch pipe from Walhampton and the elliptical pipe from Harvard Drive. The 54 inch outlet from this structure will act as the primary release, and the elliptical pipe will serve as a relief outlet when the structure surcharges. Figure 9 in Appendix B shows the proposed layout and elements for Design Option 9.

The model results for Option 9 are similar to Option 8. The 25 year – 24 hour design storm is contained below grade throughout the system. There is a slight increase in the downstream discharge compared to existing conditions, showing a net increase of 11.06 cfs. The 100 year – 24 hour storm would cause flooding conditions in this option. A full summary of the modeling results for Option 9 can be found in Table 9.1.

Table 9.1 – Design Option 9 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.65	964.60	959.77	125.82	72.77	198.59	11.06
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.86	968.16	961.72	165.54	97.05	262.59	12.08
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 9 is $1,490,242.30. See page 18 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #9

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition and Easements	LS	1	$415,000.00	$415,000.00
2	Mobilization	LS	1	$42,093.00	$42,093.00
3	Demolition	LS	1	$355,000.00	$355,000.00
4	Unclassified Excavation	CY	13,000	$8.00	$104,000.00
5	Erosion and Sediment Control	LS	1	$25,175.00	$25,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	300	$32.25	$9,675.00
8	Fence Replacement	LF	550	$10.00	$5,500.00
9	Sodding	SY	14,500	$4.50	$65,250.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	3	$3,500.00	$10,500.00
11	Stormsewer Manholes - Type B, 7'	Each	3	$5,000.00	$15,000.00
12	30" RCP	LF	160	$80.00	$12,800.00
13	36" RCP	LF	450	$105.00	$47,250.00
14	54" RCP	LF	850	$215.00	$182,750.00
15	Junction Structure	LS	1	$20,000.00	$20,000.00
16	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
17	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
18	24" RCP	LF	300	$65.00	$19,500.00
19	Sidewalk Replacement	SY	100	$40.00	$4,000.00
	10% Contingency				$97,749.30
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 19)					**$1,490,242.30**

OPTION 10

The tenth option is similar to the ninth. Four total homes will be purchased; 3829, 3833, and 3837 Walhampton Drive and 245 Kenlock Drive. In place of these four homes, two small basins will be constructed. The Walhampton basin will have a top of basin elevation of 970.00 and the Kenlock basin will have an elevation of 962.00. The existing 30 inch pipe from the proposed basin on Walhampton Drive to the proposed basin at 245 Kenlock Drive will remain in service. Downstream of the Kenlock basin, the pipe size will increase to a 36 inch pipe out to the existing storm manhole located in the rear yard of 221 Kenlock Drive that combines the Walhampton and Harvard drainage systems. The existing 48" pipe will remain in place. A new, parallel 36 inch pipe will extend along Kenlock Drive from the manhole in front of 221 Kenlock to the manhole at the Kenlock/Habersham intersection. The new 36 inch pipe will turn down Habersham, replace the existing 15 inch pipe, and tie back in to the existing 48 inch pipe. From that manhole the pipe will be increased to 54 inches. The reverse sloped 54 inch pipe will be replaced and will tie back in to the existing manhole in East Tiverton Way. Figure 10 in Appendix B shows the proposed layout and elements for Design Option 10.

The model results for Option 10 are similar to Option 9. The 25 year – 24 hour design storm is contained below grade throughout the system. There is a slight increase in the downstream discharge compared to existing conditions, showing a net increase of 15.42 cfs. The 100 year – 24 hour storm would cause flooding conditions in this option. A full summary of the modeling results for Option 10 can be found in Table 10.1.

The full model report for the 25 year – 24 hour storm of Option 10 can be found in Appendix C. Sheets P-02 in Appendix D shows a profile of the proposed improvements and the hydraulic grade line. The model pipe network map can be found on Sheet PN-03 and a layout sheet showing the preliminary design on Sheet LS-02, both sheets are in Appendix E.

Table 10.1 – Design Option 10 Modeling Results

Storm Event	30" headwall at Fritz property Top of Dam 970.00 (WSE)	Sag in Walhampton Dr. Rim 966.23 (WSE)	Kenlock Drive Low area in yards Top of Dam 962.00 (WSE)	Peak flow downstream at system outlet (OUTLET 2)[1] (cfs)	Peak flow downstream at system outlet (OUTLET 1)[2] (cfs)	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
25 year 24 hour	968.64	964.55	959.61	149.92	53.03	202.95	15.42
Existing Conditions	968.99	968.19	964.61	134.51	53.02	187.53	
100 year 24 hour	969.86	968.16	961.69	178.63	75.51	254.14	3.63
Existing Conditions	969.5	968.79	965.07	175.07	75.44	250.51	

1 – Outlet 2 – 54" pipe at the existing outlet structure
2 – Outlet 1 – 57" x 38" pipe at the existing outlet structure

The probable opinion of cost for Option 10 is $1,441,532.24. See page 20 for a detailed breakdown of the cost estimate.

ENGINEER'S OPINION OF PROBABLE PROJECT COST

Design Option #10

Walhampton Stormsewer Improvements
LEXINGTON, KENTUCKY

				EOPC	
ITEM NO.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**ESTIMATED UNIT PRICE**	**TOTAL ESTIMATED PRICE**
1	Property Acquisition and Easements	LS	1	$415,000.00	$415,000.00
2	Mobilization	LS	1	$40,186.13	$40,186.13
3	Demolition	LS	1	$355,000.00	$355,000.00
4	Unclassified Excavation	CY	13,000	$8.00	$104,000.00
5	Erosion and Sediment Control	LS	1	$25,175.00	$25,175.00
6	Concrete Drive Replacement	SF	3,000	$15.00	$45,000.00
7	Street Cuts	LF	800	$32.25	$25,800.00
8	Fence Replacement	LF	550	$10.00	$5,500.00
9	Sodding	SY	14,500	$4.50	$65,250.00
10	Stormsewer Manholes - Type A, 5' Dia	Each	3	$3,500.00	$10,500.00
11	Stormsewer Manholes - Type B, 7'	Each	3	$5,000.00	$15,000.00
12	30" RCP	LF	160	$80.00	$12,800.00
13	36" RCP	LF	800	$105.00	$84,000.00
14	54" RCP	LF	500	$215.00	$107,500.00
15	Curb Inlet Box - Type B	Each	2	$4,000.00	$8,000.00
16	Surface Inlet - Type A	Each	2	$3,000.00	$6,000.00
17	24" RCP	LF	300	$65.00	$19,500.00
18	Sidewalk Replacement	SY	100	$40.00	$4,000.00
	10% Contingency				$93,321.11
TOTAL - PROJECT COST ESTIMATE (Items 1 thru 18)					**$1,441,532.24**

SUMMARY

After evaluation of the design alternatives, it is clear that several options will address flooding at each of the previously identified problem areas in the Walhampton area (the existing 30" headwall at the Fritz property, the sag in Walhampton Dr., and the low area in yards between Walhampton Dr. and Kenlock Dr.). The main differences in the options are estimated cost and the change in downstream discharge. A comparison of the cost estimates can be found in Table 11.1. The modeling results for the ten options are summarized in two tables, Table 11.2 and Table 11.3, showing results from the 25 year – 24 hour storm and the 100 year – 24 hour storm respectively.

Table 11.1 – Design Alternative Cost Estimate Summary

	Project Cost Estimate	Project Cost Estimate (with Alt. Bid Items)
Option 1	$1,797,0325.15	$1,693,082.15
Option 2	$1,766,232.09	$1,464,355.30
Option 3	$1,688,374.69	$1,411,364.69
Option 4	$1,861,315.27	n/a
Option 5	n/a – not developed	n/a
Option 6	$1,804,759.87	n/a
Option 7	n/a – not developed	n/a
Option 8	$1,467,252.30	n/a
Option 9	$1,490,242.30	n/a
Option 10	$1,441.532.24	n/a

Table 11.2 – 25 Year – 24 Hour Storm - Modeling Results Summary

25 Year - 24 Storm Results Summary

	30" headwall at Fritz property overflow at 968.00 (WSE)*	Sag in Walhampton Dr. Rim 966.23 (WSE)	Low area in yards Rim 960.91 (WSE)**	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
Option 1	968.04	964.41	959.31	210.38	22.85
Option 2	966.65	963.87	961.55	286.71	99.18
Option 3	968.38	962.97	960.62	248.84	61.31
Option 4	967.09	962.69	958.64	245.74	58.21
Option 5	967.23	964.04	960.69	228.41	40.88
Option 6	968.62	964.29	957.92	207.39	19.86
Option 7	968.62	964.29	958.05	199.34	11.81
Option 8	968.65	964.60	959.77	198.81	11.28
Option 9	968.65	964.60	959.77	198.59	11.06
Option 10	968.64	964.55	959.61	202.95	15.42
Existing Conditions	968.99	968.19	964.61	187.53	

*Top of Dam elevation 970.00 for Options 1, 3, 4, 5, 6, 7, 8, 9, 10
**Top of Dam elevation 962.00 for Options 4, 5, 6, 7, 8, 9, 10

Table 11.3 – 100 Year – 24 Hour Storm - Modeling Results Summary

100 Year - 24 Storm Results Summary

	30" headwall at Fritz property overflow at 968.00 (WSE)*	Sag in Walhampton Dr. Rim 966.23 (WSE)	Low area in yards Rim 960.91 (WSE)**	Total peak flow downstream at system outlet (cfs)	Change in downstream discharge (+ increase/- decrease) (cfs)
Option 1	970	965.6	960.91	269.4	18.89
Option 2	968.82	966.05	961.55	312.36	61.85
Option 3	969.0	965.26	961.55	264.99	14.48
Option 4	969.65	963.18	959.86	291.48	40.97
Option 5	969.58	966.74	961.38	287.91	37.40
Option 6	969.85	968.15	962.00	273.9	23.40
Option 7	969.85	968.15	962.00	225.03	-25.48
Option 8	969.86	968.16	961.72	253.09	2.58
Option 9	969.86	968.16	961.72	262.59	12.08
Option 10	969.86	968.16	961.69	254.14	3.63
Existing Conditions	969.5	968.79	965.07	250.51	

*Top of Dam elevation 970.00 for Options 1, 3, 4, 5, 6, 7, 8, 9, 10
**Top of Dam elevation 962.00 for Options 4, 5, 6, 7, 8, 9, 10

RECOMMENDATIONS

Tetra Tech recommends that LFUCG consider implementing Option 1 or Option 10 for the final design and solution to the flooding issues associated with the Walhampton area.

Option 1

Option 1 offers a solution that could be coupled with potential development of the Fritz property. If construction of the basin could be a shared cost between LFUCG and the developer, Option 1 would become one of the most cost efficient solutions for the Walhampton area. Option 1 has

the greatest impact of all the design options in lowering the water elevations during the 25 year – 24 hour storm and the 100 year – 24 hour storm.

The largest challenge associated with Option 1 is the property acquisition and/or project coordination with the potential development of the Fritz property. The success of Option 1 will be wholly linked to this element.

Due to increasing pipe sizes using existing pipe locations, conflicts with other utilities should be minimal. Caution should be taken during construction when nearing or crossing Walhampton Drive, Kenlock Drive, and Habersham Drive. Water and gas utilities were constructed outside of the pavement, but within the right of way. The utilities were run on opposite sides of each of the three previously mentioned roads. Further utility survey will be required prior to final design of Option 1.

Option 10

Option 10 is the most cost efficient solution and does not rely on the development of the Fritz property. Option 10 also minimizes property disturbance and temporary construction easements by including the parallel 36 inch pipe down Kenlock and Habersham. This option also resulted in one of the lowest changes in downstream flow during the 25 year – 24 hour and 100 year – 24 hour storms.

The addition of the parallel 36 inch pipe through Kenlock and Habersham will also create a traffic control challenge during construction. Approximately 800 feet of stormsewer will be placed in the road and require full width mill and overlay.

Option 10 utilized the locations of existing stormsewers for the majority of the proposed conveyance system. This should minimize the number of potential conflicts with other utilities. Caution should be taken during construction when nearing or crossing Walhampton Drive, Kenlock Drive, and Habersham Drive. Water and gas utilities were constructed outside of the pavement, but within the right of way. The utilities were run on opposite sides of each of the three previously mentioned roads. Further utility survey will be required prior to final design of Option 10.

APPENDIX A

MODEL MAP – WATERSHED SUB-BASINS AND PIPE NETWORK

CCTV INSPECTION SCORING SUMMARY

APPENDIX B - FIGURES

APPENDIX C – MODEL RESULTS

25 YR – 24 HOUR STORM

OPTION 1 AND OPTION 10

APPENDIX D – MODEL PROFILES

25 YR – 24 HOUR STORM

EXISTING CONDITIONS, OPTION 1, AND OPTION 10

APPENDIX E

EXISTING CONDITIONS - PIPE NETWORK MAP

OPTION 1 MODEL - PIPE NETWORK MAP

OPTION 10 MODEL - PIPE NETWORK MAP

OPTION 1 – LAYOUT SHEET

OPTION 10 – LAYOUT SHEET

Tetra Tech, Inc.
800 Corporate Drive, Suite 200
Lexington, Kentucky 40503

859.223.8000 phone
859.224.1025 fax

www.tetratech.com